TITANIUM AND ALUMINUM IN BIOTITE FROM HIGH-GRADE ARCHAEAN GNEISSES, LANGØ, WEST GREENLAND

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Biotite grains from a variety of gneiss types were analyzed by electron microprobe techniques for Na, Mg, Aℓ, Si, K, Ca, Ti, Mn, Fe, Zn, F & Cl. TiO_2- and $Aℓ_2O_3$-contents range continuously from < 0.1 to 6.0 and 13.9 to 20.6 wt % respectively. Most occur with ilmenite, but a few coexist with rutile. Biotite in pyribolite contains the least Aℓ, and that in Kfeld-sill gneiss contains the most, suggesting that Aℓ-content of biotite is related to the bulk composition of the host rock. For a given rock type, Ti in biotite tends to decrease as Mg/Fe and Aℓ increase.

Analyses were normalized according to the following scheme: Total Cations - (K+Na+Ca) = 7, which assumes full occupancy of the IV- and VI-fold sites, but allows vacancies in the XII-fold site. Total positive charge calculated from formula proportions with all iron as Fe^{2+} exceeds the theoretical maximum of 22.00, assuming a full complement of (OH+F+Cl). This charge excess suggests the presence of VI-fold vacancies, as the IV-fold site appears filled (i.e., Σ Si + Aℓ > 4.0 in all cases).

There is an excellent correlation between charge excess and 2X Ti-content suggesting the vacancy-forming substitution: $Ti^{4+} + \square = 2R^{2+}$. Negative deviations from this correlation can be explained by the presence of small amounts of Fe^{3+}, and positive deviations by a dioctahedral substitution. The highest-Aℓ biotites have charge excesses greater than that accounted for by the Ti-vacancy substitution, suggesting that incorporation of large amounts of $Aℓ^{VI}$ in biotite requires the formation of additional vacancies by the substitution: $2R^{3+} + \square = 3R^{2+}$.

Normalization of the biotite analyses to: Total Cations - (K+Na+Ca) + $\frac{1}{2}$Ti = 7 permits the estimation of either minimum Fe^{3+} from the resultant charge deficiency, or minimum $Aℓ^{VI}$-related vacancies from charge excess.